Aspen Restoration Strategy
Fremont-Winema National Forest

Oregon State University
and USDA Forest Service

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Great-gray Owl nestlings in an old Northern Goshawk nest in an aspen stand, Lakeview Ranger District.

This stand was restored through heavily conifer thinning, allowing an open meadow to return. Old growth pine was retained. Within one year of thinning, an active Great-gray Owl nest was located in a ponderosa pine tree within the stand. (Photo: Trent Seager)

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Black bear claw marks near a woodpecker nest hole in an aspen stand on the Lakeview Ranger District (photo: Trent Seager)

Figure 1.0 Aspen stands and aspen-meadow complexes showing conifer encroachment on the Lakeview RD. (Photo: USFS)

I. INTRODUCTION

This Aspen Restoration Strategy is intended to help the wildlife biologists, silviculturists, foresters, and land managers on the Fremont-Winema National Forest in their efforts to restore functioning Quaking Aspen (*Populus tremuloides*) Ecosystems on the lands they manage. The Fremont-Winema National Forest has identified aspen restoration as a high priority for restoring wildlife habitat. An estimated 24,000 acres of aspen currently exists on the Forest. Depending upon funding, the Forest typically restores less than 100 acres of aspen per year. The purpose of this document is to provide information on the ecology and management of aspen habitats, and to provide guidance on how to assess and prioritize stands for treatments. With limited funding, it is essential that managers are restoring aspen that is considered high priority for treatment.

The Fremont-Winema National Forest covers 2.3 million acres and includes rich and diverse mixed conifer forests. However, some of the forest is comprised of dry, eastside, fire-prone forests. In these landscapes, aspen ecosystems are biodiversity hotspots. From the mushroom and insects in the deep, rich soils to the songbirds and woodpeckers in the tree-tops, aspen ecosystems support diverse biota across multiple food webs. Restoring aspen helps restore habitat for diverse wildlife while also helping to restore ecological function and processes to the forest.

The primary management objectives for aspen on the Fremont-Winema National Forest are: **1) to assure long term persistence of aspen well-distributed across the landscape**, and **2) to provide wildlife habitat by maintaining a diversity of aspen age structure**.

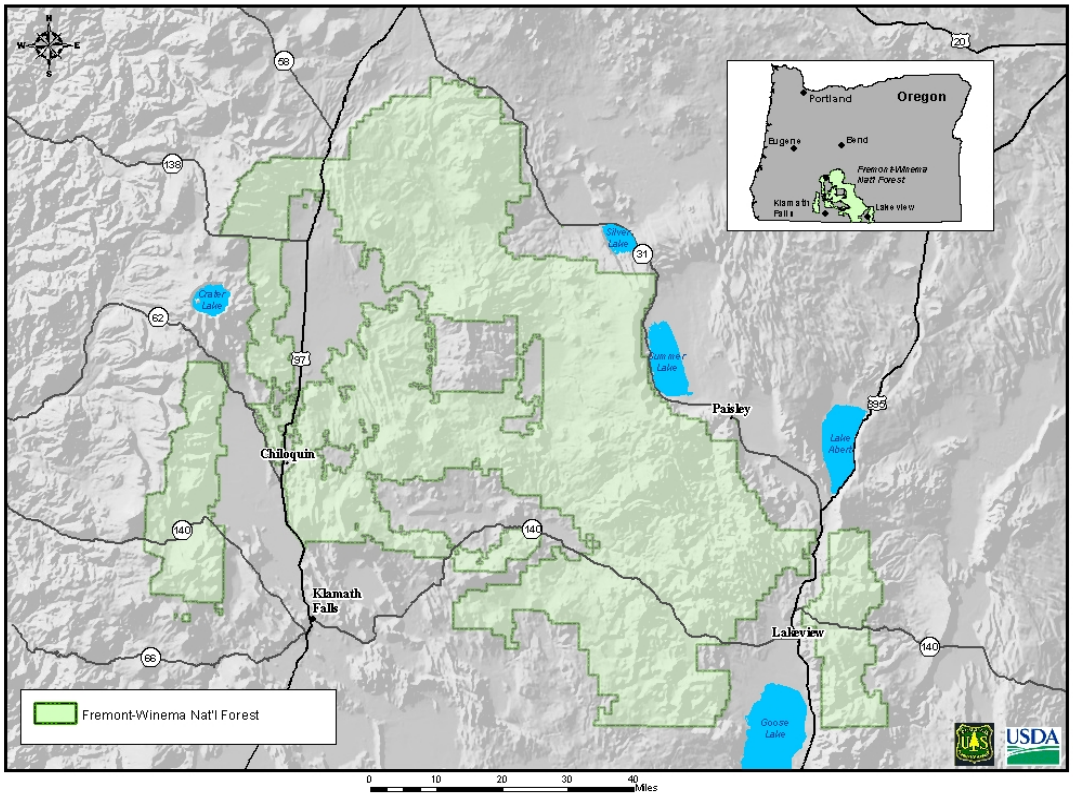

Figure 1.1 The area of the Fremont-Winema National Forest in Oregon

II. ECOLOGY AND IMPORTANCE OF ASPEN HABITATS

A. Aspen and Wildlife

Quaking aspen (*Populus tremuloides*) is the most widely distributed tree in North America (Little, 1971) and one of few deciduous trees in the intermountain west (Debyle and Winokur, 1985). Aspen is considered an indicator of ecological conditions (White et al., 1998) because of its sensitivity to drought (Hogg et al., 2008), climate change (Worrall et al., 2008), herbivory (White et al., 1998; Hebblewhite et al., 2005), fire (Romme et al., 1995), conifer encroachment (Bartos, 2001), and combined and additional stressors (Kashian et al., 2007). The recent decline of aspen has generated concerns about this habitat type in the western United States (Kay, 1997; Ripple and Larsen, 2000; Shepperd et al., 2001b).

Aspen sprouts are a preferred food source for mule deer (*Odocoileus hemionus hemionus*) and elk (*Cervus elaphus*) which may browse the sprouts so heavily that young aspen trees can't recruit into the overstory (Debyle, 1985; White et al., 1998). Deer browse the sprouts during summer and fall, while elk prefer aspen after grazing forage is diminished in fall and winter (Baker et al., 1997; Kay and Bartos, 2000; Bailey and Whitham, 2002). Livestock (cattle, sheep) also browse and trample aspen sprouts, which can suppress them from recruiting into overstory trees (Fitzgerald and Bailey, 1984; Jones et al., 2009).

Conifer encroachment can suppress aspen sprouts and overtop and kill the aspen overstory through vegetative competition for light and soil resources (Shepperd et al., 2001a; Jones et al., 2005). Historically, fire would have removed the competing conifers while also releasing larger number of aspen sprouts from the trees and soils that were affected by the fire.

Aspen trees in Oregon are typically found on deeper, richer soils than the surrounding coniferous forests (see Appendix D, Soil and Aspen on the Fremont-Winema). Aspen can therefore be viewed as an indicator of soil, moisture, nutrients, and potential of a site. The partial shading overstory and rich soil in the understory supports many herbs, forbs, and grasses in the understory community. The leaf litter under aspen is greater in carbon and nitrogen, providing more resources to the soil and ecosystem than the litter under juniper (Wall et al., 2001).

Avian diversity in aspen stands within a conifer matrix is much higher than in dry pine forest alone (Griffis-Kyle and Beier, 2003). In Oregon, aspen stands have both a higher diversity and higher density of avian species than those found in the surrounding dry and moist conifer forests (Maser et al., 1984; Sallabanks et al., 2005).

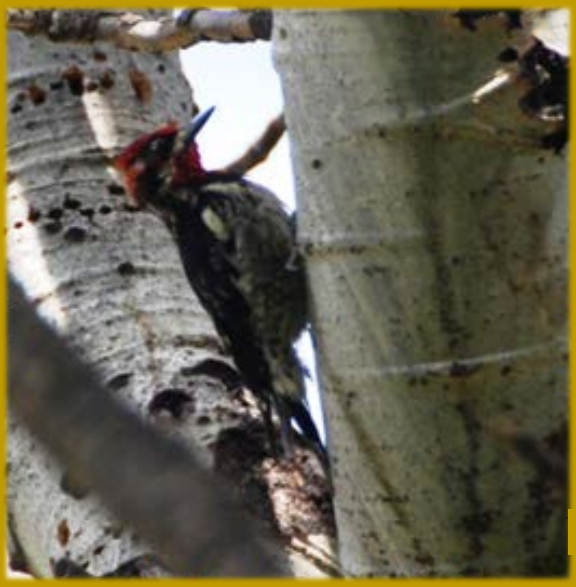

Figure 2.0

Red-naped Sapsucker

This is a *strongly interacting species*, meaning its presence is required for other bird and insect species that depend on sap wells and cavities. Sapsuckers were found nesting in aspen on each district. *(Photo: Trent Seager)*

B. Ecology of Aspen

Intermountain Region → Oregon:

While there has been extensive research on aspen ecology and restoration in the Western United States, few studies have focused on aspen in Oregon and California (Shepperd et al., 2001b; Jones et al., 2005). The concern over using intermountain research on the Fremont-Winema National Forest is that the biophysical settings that drive aspen in the intermountain area (slope, aspect, soil, etc.) can be different from those in Oregon. In the Rocky Mountains and other intermountain areas, aspen can manifest as a forest type that covers entire mountainsides and is dependent upon snowpack for annual moisture. In Oregon, aspen stands primarily exist as small distinct stands within a conifer matrix (Seager, 2010). Many of these stands are found on deeper, richer soils associated with a water source and/or higher soil moisture through the summer and into the early fall. Research on effective management and restoration of aspen in Oregon regions include: basin & range, Blue Mountains, Cascade Mountains, and Warner Mountains (see Table 1.0 for Oregon Aspen Research review).

Aspen Trees → Stand → Ecosystem:

Aspen Trees

An individual aspen stem, or rammet, is an **aspen tree**. Aspen typically reproduce by root-sprouting clonally, creating genetic identical stems. In systems that are water-limited, aspen trees can keep apical dominance and hormonally suppress the buds on the lateral roots to stop them from sprouting. This is typical in some parts of the intermountain region, where aspen depend on disturbance for release of sprouts. In contrast, many aspen stands on the Fremont-Winema National Forest and other forests in Oregon show annual sprouting with little to no apical dominance suppressing suckering (Seager, 2010). Aspen can produce seed, and if soil and moisture conditions are right, seedling aspen may grow, creating new genets in a landscape (Schier et al., 1985; Romme et al., 2005). Aspen roots are typically colonized by ectomycorrhizal fungi, helping to break down the high carbon and nitrogen leaf litter and increasing water potential in roots (Landhäusser et al., 2002). An aspen sprout becomes a tree when it is 2.5m (8') tall and has escaped browse height.

Aspen Stand

A group of aspen trees that is a certain distance from other trees (~ 65 feet) is referred to as an **aspen stand**. Formerly, this was considered a clone, but research has shown that stands of aspen may include more than one clone (Wyman et al., 2003). Aspen trees can recruit across time creating age classes. The lack understory and midstory aspen trees in a stand is termed missing age classes (see Figure 3.0). An aspen stand is a unit that allows managers to consider wildlife use across a landscape. These polygons, or stands, when placed on GIS maps allow spatial analysis of connectivity and size (or stand area) differences. The aspen stand condition (total number of trees in DBH/size classes) is one way of measuring stand health and need for restoration of aspen trees for wildlife.

Aspen Ecosystem

An **aspen ecosystem** includes the 1) understory, 2) midstory, and 3) overstory in the aspen stand. The aspen stand influences the area around it (usually 30-50 feet out), and this area of open grasses, herbs, forbs, or shrubs is considered part of the aspen ecosystem. The diverse plant communities in the understory are dependent upon the partial shade of the deciduous overstory and the deep, rich soils that hold moisture into the summer. The flowering herbs and forbs and small aspen sprouts create the lower level of the aspen ecosystem. Shrubs, tall aspen sprouts (3-7'), and small aspen trees (8-10') make up the mid-story of the ecosystem, where most nesting songbirds are found. The tall, mature aspen trees provide the overstory of the aspen ecosystem where the nesting woodpeckers, raptors, and migratory songbirds can be found.

Stable versus Seral Aspen (disturbance)

Aspen stands are largely considered to be **seral** to other vegetation types (replaced by coniferous trees) if they do not experience disturbance, such as fire (Debyle and Winokur, 1985). However, climax or **stable** aspen stands persist even without disturbance, and occur throughout the west (Debyle and Winokur, 1985; Kulakowski et al., 2004; Kurzel et al., 2007) including on the Fremont-Winema National Forest (Seager, 2010). Disturbances such as logging, fire, and insect outbreak are considered episodic, as they occur at different temporal scales. Cattle grazing and heavy herbivory are continual and therefore considered as chronic disturbances. Even-age and uneven-age stands (multiple cohorts/size classes of aspen) do not necessarily classify a stand as seral or climax. Aspen stands in Oregon can recruit across time, having multiple cohorts in an uneven age stand, and still succumb to conifer encroachment (Seager, 2010). In general, aspen stands that are isolated by shallow soil depth, rocky outcrops

Figure 2.1
Insect-based food-webs in aspen ecosystems

Flowering plants and decaying wood help drive insect-based food-webs in aspen. *Pictured here*: Western Wood Peewee foraging and nesting in aspen, Lakeview District. This is one of many species of flycatcher that use aspen for habitat on the Fremont-Winema National Forest. (Photos: Trent Seager)

(talus slopes), or other site characteristics that allow aspen to out-compete conifers are considered stable. Most stands on the Fremont-Winema National Forest are seral and will be encroached and replaced by coniferous trees without some disturbance event such as fire, timber harvest, conifer reduction, or insect/disease outbreak which results in conifer reduction.

C. Aspen Resilience

As global climate change continues to alter historic or regular precipitation and temperatures, scientists and managers have turned their focus on ecosystem resilience, or the ability of a system to recover quickly after disturbance. A 2012 aspen science symposium focused on this very issue and the presentations were published in a special edition of the journal *Forest Ecology and Management* entitled Resilience in Quaking Aspen: restoring ecosystem processes through applied science (click here for Volume 299, pages 1-100, July 2013).

Global climate change has caused an increase in drought and heat-induced tree mortality in the Western U.S. (Allen et al. 2010), including rapid die-back of aspen in Rocky Mountain region and other parts of the Intermountain West (Worral et al., 2008). Altered fire regime, chronic herbivory, and secondary insect and diseases increased aspen stand collapse (known as SAD, or Sudden Aspen Decline) during drought periods (Worral et al. 2013). Aspen stands that were less than thirty years old were resistant to both drought and secondary agents, and thus resilient. The younger stands survived while older stands around them experienced rapid decline (Worall et al., 2010).

SAD or other forms of aspen stand collapse have not been reported in Oregon. It is unknown how climate change impacts will affect aspen in Oregon in comparison to SAD and other stand decline seen in the Rocky Mountain region. For managers, understanding the historic fire regime of the landscape and its role in aspen regeneration (Shinneman et al., 2013), the impact of herbivory on aspen sprouts regeneration and recruitment into the overstory (Seager et al., 2013), and potential impact of climate on precipitation and temperature patterns for aspen (Worral et al. 2013).

Table 1.0 Oregon Specific Aspen Studies and Findings

RESEARCH	MANAGEMENT	EFFECTS	ASPEN RESPONSE
ODFW 2006	management suggestions	increase fire to induce sprouting decrease grazing to increase sprout height plant native grasses to restore understory re-connect patchy aspen stands map aspen stands at > 100 feet pixel scales	
Otting and Lytjen 2003	assessment of Steens Mountain aspen	cattle grazing greatly decreased in the 1980s	recruitment of midstory
Seager 2010	beetle-kill lodgepole snags to jackstraw deter herbivores	release water, light for overstory and understory decrease herbivory for sprouts increase sprout height and density	recruitment across time increase sprout density increase sprout height overstory trees remain
Shirley & Erickson 2001	remove conifers exclude cattle exclude deer-elk burn or plant	conifers & cattle removed - elk still browsed full exclosure needed fire increased suckers, but were browsed	landscape-level approach increase sprout density increase sprout height
Strong et al. 2010	remove conifers exclude livestock exclude deer-elk prescribe burning	examples of restoration efforts on public and private land for different factors affecting aspen persistence and recruitment	reduced shading reduced browsing increase sprout height high density sprouting
Swanson et al. 2010	remove conifers fencing prescribed burning restore understory establish new aspen	Aspen biology, wildlife use, genetic diversity, insects and diseases, and management in the Blue Mountains	reduced shading reduced browsing high density sprouting increase understory diversity aspen seeding and planting

Table 1.1 Specific Avian Use of Aspen Ecosystems

	Use of Aspen Ecosystems:	Size of Stands (Acre)	Size of Trees (DBH)	Live/ Dead trees	Ecological Role or Use	Citations
House Wren	Foraging, nesting	any	> 9.5”	Both	Use any cavity	Dobkin 1995[a]
Mountain Bluebird	Foraging, nesting	any	> 9.5”	Dead	Use NOFL cavities	Dobkin 1995[a]
Northern Flicker	Foraging, nesting	any	> 9.5”	Dead	Creates cavities	Dobkin 1995[a]
Northern Goshawk	foraging, nesting	large	large	Live	Top predator	Graham 1999
Red-naped Sapsuckers	Foraging, nesting	any	> 9.5”	Live	Creates cavities	Dobkin 1995[a]
Tree Swallows	Foraging, nesting	any	> 9.5”	Both	Use RNSA cavities	Dobkin 1995[a]
White-headed Woodpecker	Nesting		7-8”	Live	State listed species	Lindstrand & Humes 2009[a]
Birds of Prey (diurnal)	foraging, nesting	large	large	Live	Top predators	DeByle 1985
Birds of Prey (nocturnal)	foraging, nesting	large	large	Live	Top predators	DeByle 1985
23 distinct Oregon Bird Spp.	nesting	small	all	Both	Central food-web	Hetzel & Earnst 2006[a]
39 distinct Oregon Bird Spp.	nesting	all	all	Both	Central food-web	Sallabanks 2005[a]
74 distinct Oregon Bird Spp.	foraging	all	all	Both	Central food-web	Sallabanks 2005[a]
Higher avian density and diversity	Flack 1976 – DeByle 1985 – Griffis-Kyle 2003 – Hetzel and Earnst 2006[a]					

[a]Research conducted in Oregon

Table 1.2 Specific Mammal Use of Aspen Ecosystems

	Use of Aspen Ecosystems:	Size of Stands (Acre)	Size of Trees (DBH)	Live or Dead trees	Ecological Role or Use	Citations
Beaver	foraging	any	sprouts, mature	live	Ecosystem engineers: disturbance, impound water, increase wildlife	DeByle 1985
Black Bear	foraging, cub protection	any	mature	live	Top predator, seed disperser	DeByle 1985
Bobcat	foraging	any	understory	both	Mesopredator	DeByle 1985
Fisher	foraging	large	overstory	both	USFWS Candidate	Badry et al. 1997; Zielinski et al. 2004
Lynx	foraging	large	understory	both	USFWS Threatened	Ruediger et al. 2000
Mt. Lion	foraging	any	understory	both	Top predator	DeByle 1985
Mule Deer	foraging, fawn protection	any	sprouts	live	ODFW priority	DeByle 1985
Rocky Mtn. & Roosevelt Elk	foraging, calf protection	any	sprouts	live	ODFW priority	DeByle 1985
Small Mammals	foraging, nesting	any	understory	both	Central food-web	DeByle 1985
Small Mammal hotspots	bioindicators, primary & secondary consumers	any	understory	both	Central food-web	Oaten and Larsen 2009

III. CLASSIFICATION (ASPEN HABITAT TYPES) and ASSOCIATED ECOLOGICAL PROCESSES

Aspen Habitat Types on the Fremont-Winema National Forest:

1. ASPEN-MEADOW COMPLEXES

Overview: Aspen and meadows are commonly linked on the Fremont-Winema National Forest through history of fire (disturbance) and moisture (soil depth and water source). Other associated deciduous tree species, such as willow (*Salix spp*.) and black cottonwood (*Populus tricocarpa*), sometimes occur in conjunction with aspen and meadows and can greatly increase structural habitat and food-web diversity. Aspen-Meadow complexes are very important wildlife habitat on the forest.

Identification: Wet meadows on the Fremont-Winema National Forest may have aspen stands ringing them or have small patches of aspen on the edge. Some meadows and associated aspen stands have already been encroached by conifers. The historic meadows may not be noticeable unless the area is surveyed for signs of aspen, willow, or other wet meadow associated species. Historic photos may also reveal aspen-meadow complexes. In the fall, yellow aspen leaf colors around the meadows show remnant aspen stands mixed with the encroaching conifers. When surveying or

Figure 3.0 Aspen-Meadow Complex on the Chiloquin Ranger District

Note: The flooded meadow stays wet into fall and keeps aspen and conifers from encroaching into the meadows. Most wet meadows are encroached by conifers without some disturbance. The aspen here has a second cohort recruiting though still missing a mid-story. The large, old ponderosa pine indicates that fire burned historically, releasing the meadow, aspen, and open-grown pine. *(Photo: Trent Seager)*

assessing meadows, look for aspen carcasses (logs) or aspen snags to show where stands occurred (and the possibility of surviving sprouts). When mapping aspen stands, look for meadows that historically or currently linked the stands.

Management: The historic low-intensity, frequent-fire regime kept conifers from encroaching into some meadows and aspen stands on the landscape. Because meadows are preferred grazing areas for elk and livestock, aspen stands associated with them are more likely to be browsed. In some cases, browsing may help keep aspen from encroaching into the grassy meadows. However, that same herbivory pressure can keep aspen from successfully recruiting into the overstory in the aspen stand itself. Conifers use water for longer periods of time than deciduous trees. Thus, conifers that invade meadows and associated aspen stands decrease soil moisture, soil resources, and overstory sunlight that are necessary for aspen persistence. Meadow aspen stands may be heavily browsed by large ungulates that are drawn to the shrubs and understory of the transitional zone between meadows and forests. Additionally, overall loss of meadow area on the landscape can put more herbivory pressure on the remaining aspen stands. Heavy conifer reduction and prescribed burning around meadows will allow aspen (and other deciduous trees) to reclaim this area and increase overall habitat and transition zone. Aspen sprouts should be protected long enough to grow above browse height and recruit into the overstory of the aspen stand and surrounding area treated with conifer reduction or fire.

Figure 3.1 Aspen-Meadow Complex on Lakeview Ranger District

Note: Lower Right: These aspen were most likely historically connected to the larger stand, denoting a much larger aspen-meadow area. Middle: Willows line wet areas and streams that cut through the meadow. Conifers: Note their age, as this would show how many were historically present; most are post-fire suppression. (Photo: USFS)

Ecological Function: Key functions: habitat and connectivity, water retention, and natural fire breaks. This habitat type is important for deer, elk, mesopredators (bobcat, coyote, mustelids, etc.), large predators (cougar, black bear, wolf), and raptors that are considered indicator species (Northern Goshawk, Great-grey Owl). Aspen stands can be linked directly with open-grass meadows, allowing higher permeability of the landscape (*see* Singleton et al. 2002) in addition to direct connectivity for those wildlife species that require it. These complexes become natural fire breaks on the landscape. The transition zone of meadow to aspen and then conifer forest is much richer in shrubs and forbs and is preferred edge habitat for many wildlife species.

2. UPLAND ASPEN WITHIN CONIFER FORESTS

Overview: Aspen grow in isolated patches within a conifer matrix in much of the Fremont-Winema National Forest. Aspen can manifest as pure stands, long stringers, or as an understory in ponderosa pine and other conifer forests. This variation can be observed on a single landscape, owing to historical disturbance and seeding events, soil resources, and associated conifer forest type. Nesting and foraging bird diversity greatly increases when aspen stands are part of the dry conifer forests on the landscape (see Table 1.1).

Identification: In the absence of disturbance (fire, conifer reduction, insect/disease) across time, it can be difficult to locate this aspen stand type when it has been heavily encroached. Fall aerial surveys, forest survey crews, and searching along swales and

Figure 3.2

Upland Aspen in Ponderosa Pine on Chemult Ranger District

Pictured here: Aspen and ponderosa pine growing together for hundreds of years (possibly thousands).

Note: Both aspen and ponderosa overstory are encroached by lodgepole pine and dense ponderosa understory. If restored, aspen will expand into surrounding soils as competition is removed and moisture is released.

(Photo: Trent Seager)

grassy areas on the forest landscape can help locate remnant aspen stands within different conifer forests.

Management: Historically, low intensity, frequent fire regimes kept lodgepole pine and young ponderosa pine from encroaching into the aspen stands and the surrounding open ponderosa pine forest. Research shows that aspen stands can persist for hundreds, if not thousands of years (Mitton and Grant, 1980; Bartos and Campbell, 1998), including alongside ponderosa pine (Seager, 2010). Aspen associated with fir or mixed conifer forests have a longer fire-return interval and are more likely to be encroached. This aspen-type currently persists on the forest where geographic features or microenvironments (wet swales, deep soils) create a more advantageous environment for aspen or historic disturbance (e.g., logging, fire) made the stands less likely to be encroached. Long-term, these stands cannot persist without disturbance or restoration. Stands should be managed by reduction of encroaching conifers, creating an increase of moisture, nutrients, and light which will increase aspen sprouting and expansion of stand area.

Ecological Function: Aspen stringers and stands inside ponderosa pine forests greatly increase avian diversity (see Table 1.1 for details) and provide biodiversity hotspots in an otherwise species-poor dry forest. Nearly 40 distinct bird species nest and 74 bird species forage in aspen stands. Aspen within ponderosa pine forest are important for avian conservation and were found to be important for bird species richness and abundance (Griffis-Kyle and Beier, 2003). On the Fremont-Winema National Forest, important bird species, such as the Northern Goshawk, typically build their nests in coniferous trees yet forage in aspen and other habitat types that are higher in avian and small mammal diversity.

3. SITE-LIMITED ASPEN (TALUS/LAVA FLOW or WIND/SNOW FIELD)

Overview: Aspen that grow in talus slopes, lava flow areas, or scab rock flats are usually stunted by site-limitations, i.e, the shallow soil decreases rooting zone and resources. Higher elevation aspen that are exposed to the elements are usually stunted by deep snow levels, wind, and late spring thaw.

Identification: The small, stunted stands are usually obvious. However, it is important to not assume that small trees are necessarily old and stunted. Look for aspen snags or carcasses (logs) to show what previous cohorts of aspen reached as their DBH and height potential. If the snags and carcasses are also stunted, then the site can be classified as Site-limited.

Management: Aspen stands in lava flows or rocky areas are usually not invaded by conifers nor browsed by wild ungulates or domestic livestock. This allows them to show recruitment in the absence of competition and herbivory. These stands usually do not need management intervention or restoration (Shepperd et al., 2006). Because this stand-type does not provide the same wildlife habitat as typical aspen stands (multi-

storied, diverse structure and plant communities), it should noted separately when doing landscape-level planning.

Ecological Function: Site-limited aspen stands do not function as biodiversity hotspots. Their understory is almost entirely lacking of the flowering plants and insects. The basal growth happens in such small increments that the wood is usually too dense and not large enough (DBH) to allow woodpeckers to excavate cavities. These stands primarily act as genetic placeholders. They can provide genetic diversity on the landscape and potentially help in producing or fertilizing seed during aspen seeding events. As such, these aspen stands types should be low priority for mapping efforts, and should be noted separately. This will help make landscape-level planning easier when considering connectivity, permeability, and restoration priorities based on stand locations.

Figure 3.3
Site-limited Aspen: Talus Slope

Often site-limited and stunted, these aspen do not function like other aspen stand-types. They are not readily used by wildlife, lack understory, and have little food-web diversity.

(Photo: Trent Seager)

4. ASPEN/SAGEBRUSH ECOTONE

Overview: Aspen that grow in sagebrush communities can provide valuable wildlife habitat for desired species such as the sage grouse (Bates *et al.*, 2006). Sagebrush communities have much greater diversity and habitat with the presence of fire or other disturbance. The aspen/sagebrush ecotone is considered a transition zone that is at high risk of loss without restoration, fire, or protection of sprouts from browsing (Campbell and Bartos, 2001).

Identification: Areas of the Fremont-Winema National Forest that are being thinned for juniper management may contain aspen stands that were once part of an

aspen/sagebrush ecotone. This stand type is found in lower elevation sites and in openings in the dry conifer forests. Open sage-grassland systems were part of low intensity, frequent fire regimes. Where these systems crossed deeper soils and wet areas, aspen seeded in and persisted across time. These aspen stands often appear decadent and near collapse in dry juniper-sage areas. Upon closer inspection, aspen snags, carcasses (logs), and sprouts that have been browsed across time show that the stand area and root systems are much larger and could persist if given protection.

Management: Sagebrush as an aspen understory should not exceed 10% allowing other important vegetation, i.e., aspen sprouts, grasses, herbs & forbs, and diverse understory to persist in this ecotone (Campbell and Bartos, 2001). Reduction of juniper and other encroaching conifers, opening up and thinning of sagebrush, and protection of sprouts are a high priority for management. Because this stand type is preferred browse during summer and winter range, protection of sprouts is important (fencing, down trees). Most aspen stand types on the east-side of the forest (former Fremont National Forest) only showed light to moderate browsing. This was not the case for aspen/sagebrush stands, which were heavily browsed by livestock and deer-elk herds (see photo above), emphasizing the need for protection. For stands with only a few aspen trees left, fire or clear-fell coppicing could re-set the stand and allow hundreds of aspen sprouts to erupt. These sprouts would need fencing or other protection to assure their persistence until they reach 8', which is above browse height.

Ecological Function: Aspen trees provide critical structure and understory diversity where sagebrush transitions to conifer forests or riparian areas. Important bird species, such as the sage grouse, prefer aspen/sagebrush ecotone. Aspen trees in an otherwise dry sage steppe area are indicators of moisture and provide partial shade for a rich diversity of grasses, herbs, and forbs. This understory creates the basis of a food-web for insects and small mammals. The same understory is preferred browse for domestic and wild ungulates, making this stand type more heavily browsed than others.

Figure 3.4

Aspen/Sagebrush Ecotone on Lakeview Ranger District

Pictured here:
Aspen/sagebrush ecotone encroached by sage, juniper and ponderosa pine with heavy browsing on all aspen sprouts across time (lack of mid-story or understory recruitment).
(Photo: Trent Seager)

5. RIPARIAN ASPEN

Overview: Riparian aspen can manifest as long, narrow, corridors of aspen alongside rivers and streams, or as part of larger riparian forest habitat. Woody riparian habitat has the highest diversity of avifauna in the semi-arid west, including eastern & central Oregon (Dobkin et al. 1995). Areas where aspen grow in mixed hardwood riparian forest may be the areas of higher biodiversity, including nesting bird species.

Identification: Riparian aspen may manifest as narrow bands that are difficult to detect until fall when the leaves turn gold. In areas where black cottonwood (*Populus tricocarpa*) line streams, make sure to look closely for the presence of aspen. Additionally, aspen stands may be on the hillsides, and have stringers of trees growing down into the riparian zone.

Management: Areas on the Fremont-Winema National Forest where aspen grow alongside willow (*Salix spp*.), black cottonwood, and other hardwoods should be a high priority for conifer reduction and/or restoration. This complex of riparian hardwoods provides tall overstory and dense understory for nesting and foraging birds. Successional management, or conifer removal in and around aspen in riparian zones, was shown to increase nest success and decrease nest predation in songbird species (Hetzel and Earnst, 2006). Riparian areas can be natural fire breaks and historically did not burn as frequently in low severity fire regimes. Conifer reduction would increase aspen persistence, decrease competition for light, and restore the natural fire break to the riparian aspen corridor.

Ecological Function: Aspen trees provide critical structure and habitat for nesting bird species along riparian areas. Because aspen provide refuge from predators that access bird nests in nearby willows and conifers, riparian aspen can be key for nest success (Hetzel and Earnst, 2006).

Figure 3.5
Riparian Aspen on the Klamath Falls District

Pictured here: Aspen in a riparian zone with wet meadow and willow in front and taller cottonwood trees in back. The aspen mid-story, overstory, and cottonwoods create diverse structural habitat. Note some conifer encroachment. (Photo: Trent Seager)

IV. STAND AND LANDSCAPE LEVEL ASSESSMENT OF ASPEN

Stand-level Assessment

Aspen stands can be assessed by many different methods and approaches. The simplest ways for land managers is to use a **Rapid Visual Assessment** with the option of including **Simple Data Collection**. The basic premise is for managers to be able to quickly understand the current dynamics of the aspen understory and overstory, including current threats (conifer shading, herbivory, etc.). While these two tools are not designed for scientific analysis, they are very informative for land managers and can help guide management decisions. These assessment tools can assist specialists with prioritizing aspen stands for treatment when funding is limited. The description of each assessment tool is below, followed by example field sheets.

Rapid Visual Assessment

This is done at the aspen stand level (or polygon), and unless the stand is large, can be done from a single point. The idea is to look around and assess the condition or the story of the aspen stand. When doing a rapid assessment, it is important to include understory assessment for stands missing small diameter (age class) aspen trees (see Appedix B for full tool; abbreviated tool shown here).

1. **Assess the OVERSTORY**:

   a) How many live overstory Aspen Trees are there?

   b) What size classes are the overstory Aspen Trees?

   c) How encroached is the stand by Overstory Conifer trees?

   d) Are there very many aspen snags over 9” DBH?

2. **Assess the UNDERSTORY**:

   a) Sprout Density: how many sprouts do you see?

   b) Sprout Height: how tall are the sprouts?

   c) Shrub component: for habitat type and area, what is in the stand?

   d) Conifer Saplings: how dense and tall are they?

   e) Age conifers carefully as older conifers may persist in the mid-story.

3. **FINAL: Assess the STAND CONDITION and TRAJECTORY**:
   Use the above Rapid Assessment to place the stand into one of the following categories:

   Persisting (no concerns)

   Stable (fine for now and next 20 years)

   Decreasing (Treatment required: overstory present, but no recruitment in last 35 years)

   Threatened (Treatment required: overstory decreasing and threatened by conifers, no recruitment in last 35 years)

Landscape-level Assessment

For most land managers, aspen restoration will occur as part of a larger project that is reducing fuels, restoring dry forest or mixed conifer habitat. This is logical for many reasons, and aspen restoration should be integrated into of all the larger projects on your district and forest. Additionally, aspen ecosystems make natural fuel breaks and require more conifer reduction (90-100%). From an aspen habitat or ecosystem point of view, the importance would be connectivity and landscape permeability (based on species of interest) and overall habitat area. In the end, most managers blend project needs, species of interest, and aspen ecosystem restoration. This document will walk through a Landscape-Level Assessment based on aspen ecosystems and habitat, recognizing that this will be adapted to fit into project work that is not solely aspen-focused.

Using Three Steps for Landscape-level Assessment:

First:
Identify all mapped and known stands and then stair-step the stands:

1. Long corridor stands and/or large stands (see Figure 4.0)
2. Core stands that are more circular than long (see Figure 4.1)
3. Key connections (see Figure 4.2)
4. Smaller stands that fill out the landscape (see Figure 4.3)
5. All remaining stands (see Figure 4.3)

Second:
What's under-represented on the landscape? (e.g., small patches, large stands, meadow stands, deep forest stands, mixed willow-cottonwood stands)

Third:
What aspen stands and types are at high risk for loss among the aspen stands that you are aware of on your landscape (project area and surrounding area)? And what aspen stands and types are not at risk, and are doing well?

Using all three of these steps, a manager can start to prioritize aspen restoration on the landscape. While restoration may be occurring at the project level, the landscape level can help inform project level decisions.

Figure 4.0

Many species of raptors forage and nest in aspen

As biodiversity hotspots, aspen ecosystems provide habitat for diverse species of small mammals and birds. This attracts many predators, including raptors.
(Photos: Trent Seager, raptor nest; Tom Knudson, Northern Goshawk)

An Example of How to Stair-Step Aspen Stands when Prioritizing Treatment

Using maps of the aspen polygons on the Lakeview Ranger District

Historically, the US Forest Service managed at the stand level. This proved to be costly. The move toward watershed and landscape level management allows for a greater understanding of connectivity, corridors, and permeability for wildlife. Aspen can be managed at the stand level, which matches the prescription for silvics. In order to prioritize and be strategic with aspen restoration, the landscape should be considered even when treating at the stand level. Below are a series of figures showing aspen stair stepping. Aspen prioritization is a puzzle, and when it is viewed on the landscape the importance of the individual stands becomes clearer.

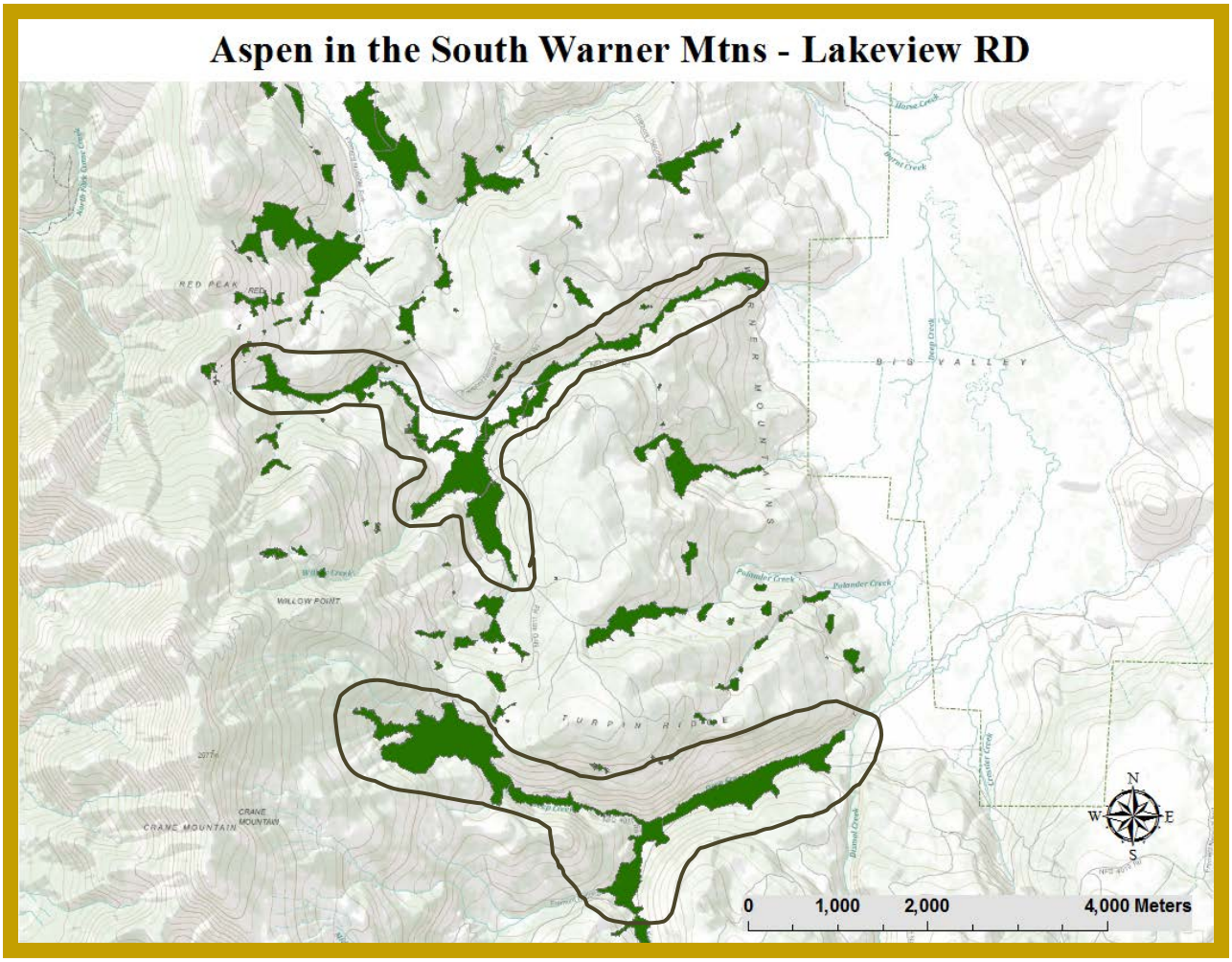

Figure 4.1 Long Corridors

In this figure, brown circles note the **Long Corridor stands** with aspen along wet meadows and streams. Extensive aspen stands provide habitat for connecting between low valleys and upper meadows and forests. These stands also make the landscape more permeable to dispersing and migrating species. On this landscape, Long Corridor stands allow the valley and the mountains to be connected.

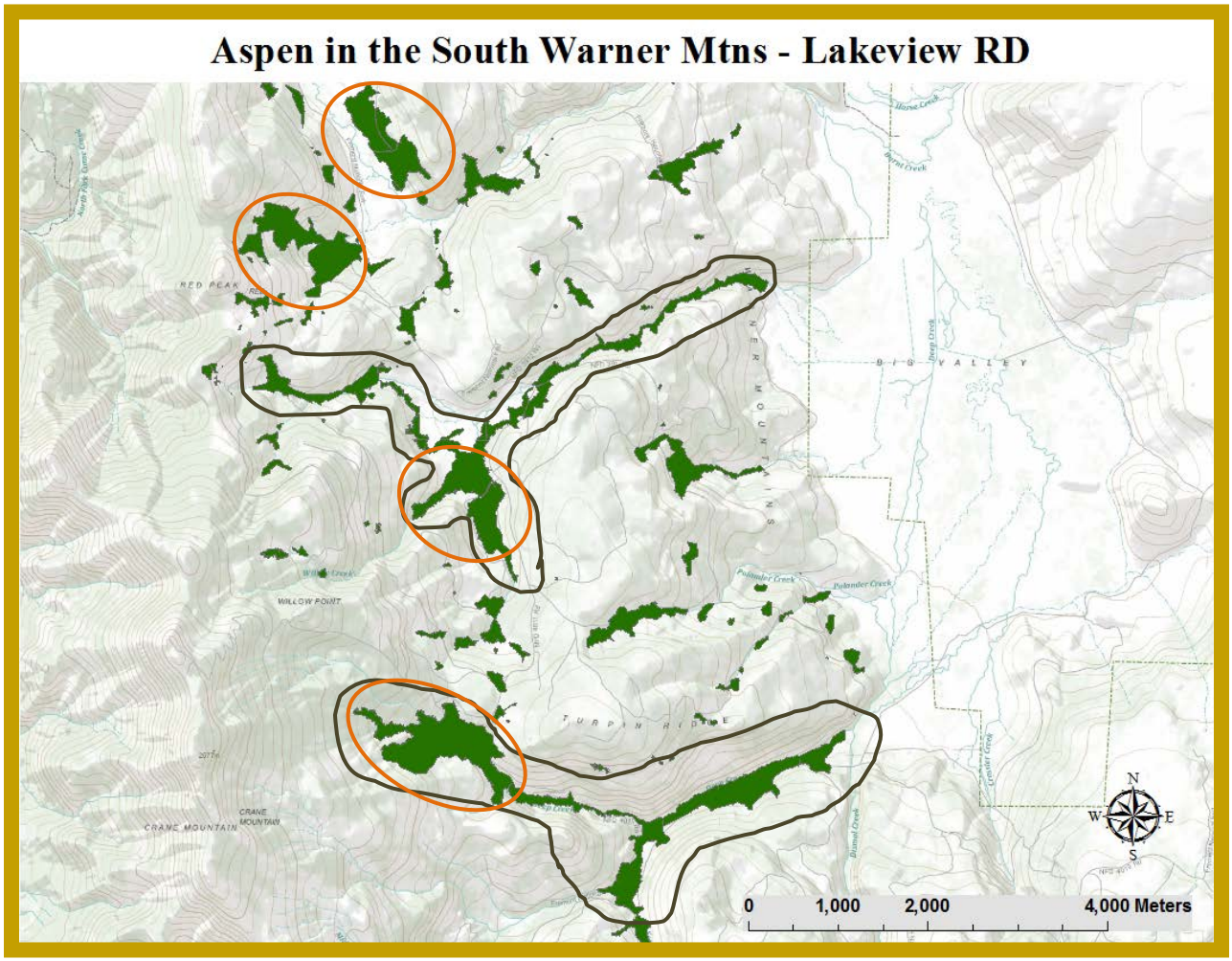

Figure 4.2 Core Stands

In this figure, orange circles have been added to note the **core aspen stands** in addition to the Riparian Corridors. Core Stands are larger (as opposed to longer) and provide more interior habitat for wildlife species that need it. This example shows that these stands may go up in elevation, creating a transition zone between riparian, meadow, and conifer forest. Note that in this example, the **Long Corridor Stands** include some **Core Stands** within them.

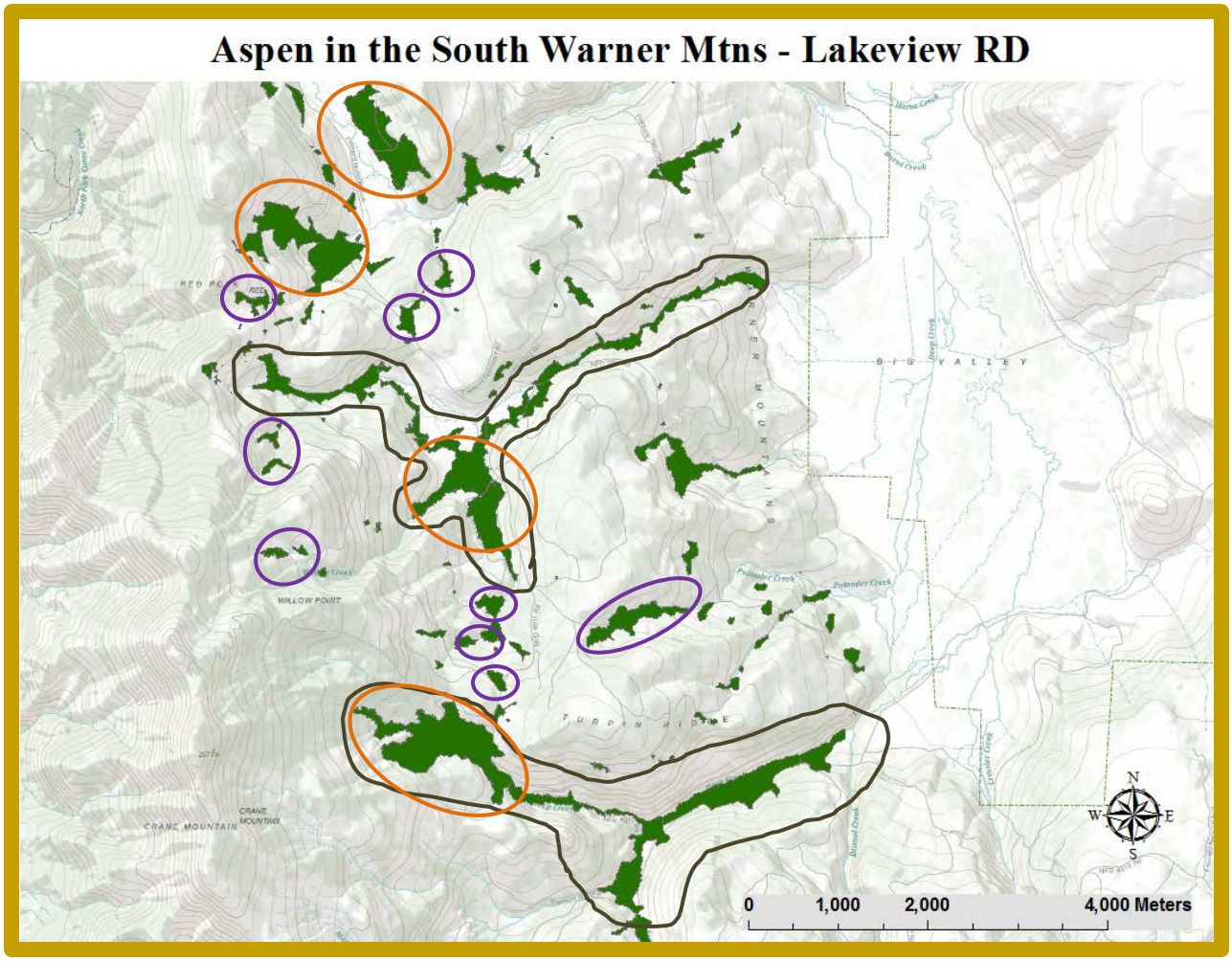

Figure 4.3 Key Connections

The purple circles shown in this figure note key areas that help connect the larger (core) stands and longer (corridor) stands. For animals dispersing and for heterogeneity on the forested landscape, restoring small patches of aspen will help aspen-dependent species and dry forest species that need diversity on the landscape for foraging. **Key connecting** stands allow the landscape to be more permeable to dispersing and migrating species.

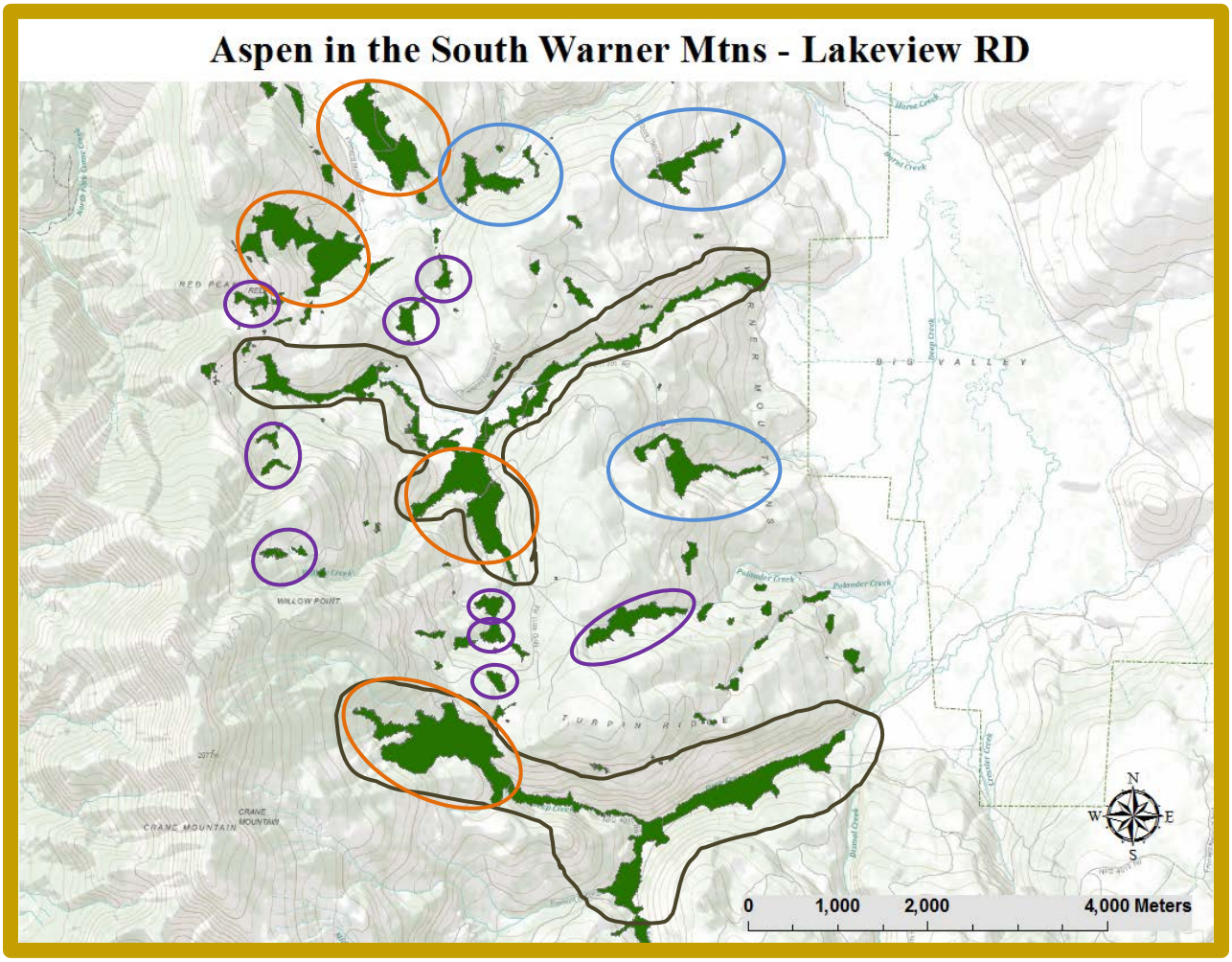

Figure 4.4 Smaller stands

The blue circles in this figure note **smaller stands** (not quite core stands) that help fill out the landscape. These stands may contain most of the species of interest, and if allowed, will expand into larger core stands.

V. PRIORITIZING ASPEN RESTORATION

A landscape level assessment allows managers to have stand area and location. To prioritize treatment, this information should be merged with (1) wildlife species aspen habitat needs, (2) aspen stand types, and (3) aspen stand condition and trajectory. It is important to note that this information will change depending on the project area or landscape. Whenever possible, assess surrounding landscapes or project areas to account for cumulative effects.

Priority treatment comes from the aspen management objectives of the Fremont-Winema National Forest:

- to assure long term persistence of aspen well-distributed across the landscape
- to provide wildlife habitat by maintaining a diversity of aspen age structure

With these in mind, consider the information below when prioritizing stands for treatment:

1. What is the least represented and most important (a) aspen age structure, (b) aspen stand type, and (c) aspen stand size for wildlife species in the (1) Zone, (2) District, (3) Watershed, and (4) Project planning levels? Note these might be different wildlife species at different planning levels. [See Tables 1.1 and 1.2 for details]
2. What is the least represented aspen stand size (polygon, see Figures 4.1–4.4) on the landscape? Did you consider stand condition? Some stands might be present but not recruiting nor on a trajectory to last.
3. What is the least represented aspen stand type (Section III. #1 through #5) on the landscape? Did you consider stand condition? Some stands might be present but not recruiting nor on a trajectory to last.

An analysis of this will allow mangers to prioritize treatment of aspen polygon types and aspen stand types needed to assure they are well-represented for **long-term persistence on the landscape**. Priority should also be placed on aspen stands that would **maintain or increase diversity of aspen age structure needed to provide habitat** for wildlife species highlighted by the project or forest.

It is important to note that aspen stand distribution on the landscape can be driven by many factors. This includes historic stand presence, previous treatment or disturbance, and geographical features and biophysical settings. Not all landscapes will have equal presence of aspen or areas suitable for aspen expansion. Additionally, stand presence may not be known without surveys of the area (mapping polygons) or review of historic or current aerial photos.

VI. ASPEN TREATMENT AND PRESCRIPTION OPTIONS on the FREMONT-WINEMA NATIONAL FOREST

Land managers have many options for prescriptions to help aspen stands persist or expand on the landscape. Some aspens stands will need little to no management, while others may need protection from browsing or encroaching conifers. When adequate time and funding allow, complete the previous described aspen assessments. The best tool for prioritizing treatment is to know what aspen ecosystems already exist on the landscape and the current status of those ecosystems. Landscape level prioritization is outlined above (Section IV). The Fremont-Winema National Forest management objectives for aspen are (1) to assure long term persistence of aspen well-distributed across the landscape, and (2) to provide wildlife habitat by maintaining a diversity of aspen age structure. As outlined above: project, watershed, or landscape level aspen restoration should consider both objectives.

Another important interdisciplinary team process is to identify at the landscape scale acceptable higher fuel loads in areas of conifer thinning from aspen. An acceptable threshold for surface fuel loading is not given in this document, since jackstraw fuels are encouraged to inhibit browsing and fuel loads need to be analyzed as a hazard at the landscape scale.

After prioritizing aspen restoration at the landscape level, treatment and prescription occurs at the stand level. Below is a list of prescription options for aspen management at the stand level on the Fremont-Winema National Forest.

1. Conifer Thinning

Conifers that encroach upon aspen stands may compete for limited resources (e.g., light, moisture, soil). Aspen are shade intolerant and susceptible to conifer competition and replacement in the absence of disturbance such as fire, timber harvest, or pest/disease outbreak. Aspen trees are short-lived. Some aspen stands are early seral, giving way to conifers that shade the sprouts and understory, halting aspen overstory recruitment. Conifers will eventually overtop the aspen, reducing the aspen overstory and contributing to stand collapse.

Most aspen stands on the Fremont-Winema National Forest are associated with springs, seeps, or wet areas and therefore not water-limited. These stands produce sprouts on an annual basis, and in the absence of heavy herbivory, show decadal pulses of overstory recruitment (Seager 2010). Some stands show conifer encroachment over time, thus limiting aspen stands to the wettest areas where conifers encroach last. Conifer treatments would reduce or remove vegetative competition, allowing for aspen stand sustainability and possible expansion of their sprouting zone. If browsing of aspen sprouts is a concern, consider jackstraw or hinging of down logs or fencing.

An objective for treatment of aspen by conifer reduction is enhancement of the stand by reducing shading and competition. A variety of methods may be employed depending

on the individual aspen stand, soil protection, wildlife objective, and fuel load. An interdisciplinary process within the Decision document should be undertaken. Although reducing conifer competition fully, allowing the aspen component the greatest ability for survival may be a goal, it has been shown that aspens and conifers representing less than 20% canopy closure can coexist (Swanson et al. 2010). Examples of other management objectives for partial conifer retention include large or old tree conservation, stream shading, wildlife habitat diversity of aspen with some large conifers, and maintaining diversity of other conifer species such as spruce and whitebark pine.

The interdisciplinary process and Decision document would include resource protections and guidelines addressing whether manual or ground based equipment is employed. Conifers may be thinned, girdled, or possibly removed. A variety of slash treatments could also be employed. For example, if hand piling and burning is implemented, keep piles at least fifteen feet away from aspen boles requiring protection from radiant heat damage.

Conifer reduction from within a buffer zone surrounding an aspen stand is advisable, releasing light and resources to the aspen stand and thereby stimulating its regeneration, allowing for stand expansion. Buffer zone width may range from 60 to 200 feet out from aspen stems or the aspen stand perimeter. The width is dependent on the possible aspen expansion zone defined by soil and water holding capacity, plant community vegetation type, and limiting shading to less than 20% from conifer canopy closure. Limit shading with radial clearing treatments going out one and one-half to two tree lengths from the outside aspen stems. The buffer width may also vary due to the expected time for reentry addressing the next conifer reduction. If a conifer seed source persists in the area, then a subsequent treatment of conifer seedlings and saplings

Figure 5.0

Aspen stand at risk of loss from conifer shading

In the absence of fire or conifer thinning, many aspen stands will be replaced by conifers. Note the mountain pine beetle kill on the left side, releasing the aspen. (Photo: Trent Seager)

could be necessary within twenty to thirty years.

Depending on resource protection, access, and funding, aspen enhancement may be limited to manually treating the conifer competition. This may create an upper diameter size limitation due to fuel loads or commercial concerns. While downed trees and jackstraw may protect sprouts from browsing, excessive conifer slash could negatively impact sprouting and sprout growth via shade and lower soil temperature.

Stand Description: Multi-story ponderosa pine with a quarter acre aspen stand representing approximately 20 scattered aspen stems of 4-10" DBH.

Example Prescription: Radially thin conifers from within and around the aspen stems for 60 feet. Reduce the pine basal area to below 20% canopy cover to reduce shading for 60 to 150 feet from the last aspen stem. Retain the large and old ponderosa pine.

2. Fencing

Fencing and other ungulate barriers decreases herbivory and allows aspen sprouts to recruit into the overstory. Fencing aspen stands has been shown to be an effective approach on other national forests and districts in Oregon (Swanson et al. 2010). Fencing should extend 50-100 feet beyond the last live aspen stem and include the surrounding buffer areas treated. Multiple fencing types are available and include: buck and pole, wire cages, plastic mesh, and welded wire. The type of fencing needed depends upon the (1) amount of annual snowfall and impact, (2) livestock and ungulate suite in the area, and (3) budgeted cost and maintenance expenses. Buck and pole

Figure 5.1

Livestock Fencing

Wildlife Biologist Jennifer Sanborn on the Chiloquin Ranger District with livestock fencing around an aspen stand. Note the aspen sprouts and midstory aspen release after fencing, even with wild ungulate access and conifer encroachment. (Photo: Trent Seager).

fencing can be used from the lodgepole pine trees cut on-site. The Deschutes National Forest used buck and pole fencing, allowing the fence to degrade across time (see Figure 6.9). However, some of the fence may fall and trap deer, elk, or livestock inside. Plastic mesh and high-tensil wire fencing allows a few people to fence large areas of a stand in a short period of time. This fencing can be removed when aspen sprouts reach above elk browse height (2.5m or 8'), allowing complete access to the stand and not trapping any ungulates inside.

3. Jackstraw

Jackstraw is when an area has heavy tree-fall from purposely dropping trees through forestry practices or after an insect or disease outbreak creates snags and blow-down (Seager 2010). This haphazard falling of trees or snags creates log barriers for ungulates to parts of an aspen stand allowing release of aspen sprouts. The Fremont-Winema National Forest had extensive jackstraw following the mountain pine beetle outbreak in the late 1980s on the Chemult Ranger District. This allowed aspen stands to recruit hundreds or thousands of young aspen trees (Seager 2010). Creating jackstraw or hinging trees as part of restoration can deter elk, deer, and cattle from over-browsing aspen stands (Kota and Bartos 2010). Jackstraw can be done after conifer thinning. Unwanted trees should be left around and within an aspen stand to be dropped after the thinning treatment has occurred.

4. Alter Grazing

Aspen ecosystems that are grazed by domestic livestock (cattle, sheep) and wild ungulates (elk, deer) experience greater impact than those stands that are browsed by only wild ungulates (Kay and Bartos 2000; Seager 2010). Decreasing grazing impacts by altering season length, decreasing livestock numbers, or resting grazing allotments can allow for aspen sprouts to increase in growth and escape browse height (2.5m or 8

Figure 5.2

Jackstraw

Aspen stand with jackstraw – following mountain pine beetle outbreak and subsequent tree fall on Chemult Ranger District. Note the sprouts and midstory that are escaping from herbivory. Ungulate trails and browsing still exist in parts of the stand, but the unseen downed logs protect many of the sprouts (Photo: Trent Seager)

ft). Studies show that cattle displace elk and deer spatially and temporally (Graham et al. 2010). Additionally, most livestock damage to aspen sprouts occurs late in the season when other forage is depleted or lacks protein. Removal of cattle before the range is depleted for the season would decrease the impact of grazing on aspen sprouts and recruitment. Altered grazing or fencing helps increase the diverse forbs that are important components of aspen ecosystem understories.

5. Prescribed Burning

Fire has played an important role in maintaining aspen on the landscapes of central and eastern Oregon, including the Fremont-Winema National Forest (Seager 2010). Fire helps aspen stands by increasing aspen stand size through post-fire aspen sprouting and removal of competing conifers. Aspen seeds need bare mineral soil to establish (Shepperd 2001). While seeding events can occur annually, fire or other disturbance is needed to create bare mineral soil. Prescribed fire has long-been used to reset aspen stands by killing overstory aspen and conifers and inducing high density of aspen suckers. The removal of the overstory aspen induces root-sprouting by removing apical dominance which can suppress aspen suckering through hormonal control (Frey et al. 2003). Fire increases soil temperatures and creates a pulse of nutrients, increasing sprout growth and survival (Frey et al. 2003).

Most aspen stands on the Fremont-Winema National Forest are associated with springs, seeps, or wet areas and therefore are not water limited. Stands with high soil moisture produce sprouts on an annual basis, and in the absence of heavy herbivory, show decadal pulses of overstory recruitment (Seager 2010). While such stands may not require fire to stimulate aspen suckering, it may play an important role in keeping conifers from encroaching the aspen stand (Kurzel et al. 2007).

The historic fire regime on the Fremont-Winema National Forest varied with forest type. As such, prescribed burning may not be suitable for aspen stands in all types of associated conifer forests. Fire that is intense enough to kill large conifer trees will also kill the residual aspen trees. Low intensity fires that are designed to reduce fuel loads and kill seedling/sapling size conifers, may be intense enough to kill residual aspen. In a study by Perala (1974), fire applied to even age suckers in an aspen stand killed the suckers and had subsequent weaker suckering.

Fire can be used to increase aspen stand size (area) or increase sprout density. In stands that have few mature aspen trees, or lack sprouting, fire may be an appropriate tool. In areas with heavy herbivory, burning can increase suckering and draw in more wild ungulates and domestic livestock. Managers should consider options for protecting the suckers in parts of the stand. Once the aspen overstory has been removed, the suckers are the only living part of the clone or stand, and heavy herbivory could stop the young aspen from recruiting into small trees, causing stand collapse.

In prescribing fire, field assessment should be done by Fire Ecologist and Silvicultuirist to prepare goals and objectives for the Prescribed Fire Plan. The stand and landscape condition of aspen need to be considered in this assessment. For example, at the stand scale the objective may be to protect an individual aspen stand that provides special

value; at the landscape scale, there may be the need to use prescribed fire to increase the diversity in aspen age classes. In some cases, prescribed fire may be a benefit to the restoration of aspen while in other circumstances there may be the need to protect aspen from prescribed fire management.

6. Decadent or Declining Stands

Aspen stands that have been impacted by browsing or conifer competition across time may be in decline with only a few remaining decadent rammets or trees (see Figures 6.3 and 6.8). Resource managers should first see if the stand responds to conifer reduction and/or fencing. The root systems in an aspen stand may gradually die under diseased or declining mature trees. Depending on the local factors affecting the stand, the decadent trees may continue to suppress suckering and drain the carbohydrate reserve found in the roots. In contrast, some mature aspen stems release large number of sprouts as the rammet begins to decay.

The stand should be monitored for a few years after conifer thinning and/or fencing. If no suckering has occurred, restoration options include mechanically sever the roots, clear-fell coppice, or burn the remaining aspen overstory trees to promote suckering. Post-treatment suckers should be protected from herbivory and fire to assure their survival since no overstory trees remain to allow continued suckering. There is some risk that the stand will fail to sucker and thus be eliminated by the treatment. Managers should note that burning or cutting a stand results in the potential for complete loss of overstory aspen habitat that is important to some wildlife species. As such, aspen overstory removal should be part of a landscape level restoration plan that notes nearby stands which have larger overstory trees (Plan Objective #1). This helps assure diverse habitat types in aspen stands on the landscape (Plan Objective #2).

Mechanical root stimulation may be useful to expand or rejuvenate stands where retention of existing mature aspen trees is highly desired. Protection from browsing post-treatment is essential if previous suckers were eliminated or suppressed by herbivory (Shepperd 2001). Mechanical root stimulation is usually done with a dozer-mounted ripper. Disking to stimulate aspen suckering is not recommended due to extensive root damage and internal decay (Basham 1988; Perala 1977).

Burning and other aspen overstory removal has been implemented on different districts on the Fremont-Winema National Forest. Nearby Deschutes and Malheur National Forests have also burned or clear-fell coppiced aspen stands. Visiting these sites may allow managers to have a better understanding of the treatment, including discussion of the risks associated with overstory removal. When burning or clear-fell coppicing, avoid treatment soon after leaf flush, when carbohydrates have been translocated to the stems and root reserves are low (Schier 1976). Dormant-season felling is preferred (Schier et al. 1985b). When restoring a decedent stand, ensure that fencing is in place to protect the suckers.

Table 2.0 Aspen Fire Studies in Oregon

	Treatment	Effects	Aspen Response
Bates et al. 2006	Cut junipers Spring burn Fall burn	Spring burn = ↑ shrubs & herbs Fall burn = hotter & more sprouts both burn types = ↑ aspen sprouts	increase sprout density some overstory trees lost
Wall et al. 2001	Cut junipers Burn Deter ungulates	Juniper changes soil Juniper decrease aspen sprouts Juniper decrease aspen overstory	increase sprout density some overstory trees lost

VII. PHOTO SERIES OF DIFFERENT STAND CONDITIONS

Series #1: Desired Conditions/Multi-storied Aspen Stands

Figure 6.0 Multi-storied Stand

This stand is showing sprouts growing into the midstory and recruiting into the overstory. The stand is expanding in size. Note that you cannot see the white bark on the mature aspen stems in the back because the mid-story is so dense. Chiloquin Ranger District. (Photo: Trent Seager)

Figure 6.1 Historical Release

This stand is showing a midstory that recruited into the overstory after some historical release (fire, disturbance, altered grazing, decreased browsing) that did not remove the overstory. The stand is not necessarily expanding in total area. It has an understory and midstory with high structural diversity and wildlife habitat. Note the midstory goes back into the stand and the wet meadow and shallow soil halts expansion into the foreground. Chiloquin Ranger District. (Photo: Trent Seager)

Series #2: Release of Aspen Sprouts

Figure 6.2 Release of Sprouts

This stand is showing a recent (1-5 years) release of sprouts most likely from altered grazing or decreased herbivory. Note the dense sprouts going all the way through the stand. The lack of a mid-story shows that this is a recent event and historically sprouts were not recruiting (8' or 2.5m). Klamath Ranger District. (Photo: Trent Seager)

Figure 6.3 Low Sprout Density and High Herbivory

This stand is heavily encroached by conifers with dense shading. Where sunlight does reach the forest floor, aspen are root-sprouting. However, heavy herbivory is keeping the sprouts suppressed and below knee height. This stand needs conifer reduction followed by fencing or jackstraw to reduce herbivory. Chiloquin Ranger District. (Photo: Trent Seager)

Figure 6.4 Historic Release of Sprouts

This stand has a recently recruited aspen midstory (8'-10' high) with dense sprouts. It also has lodgepole trees in the stand and recent encroachment of fir and pine saplings. Reduction of the conifer at this stage would (1) be low-cost, (2) allow more rapid growth of the aspen saplings and sprouts, and (3) allow the aspen stand to expand in total area. Klamath Ranger District. (Photo: Trent Seager)

Series #3: Pre-commercial Thinning

Figure 6.5 Thinning Out Conifers

This aspen stand was treated with a pre-commercial thin (removal of all conifers ≤ 9" DBH). The conifer saplings are piled for winter burning. The pre-commercial thin allows you to see the aspen trees. The conifer commercial harvest that follows will release more water, light, and nutrients for the aspen. Note: there are few, if any, aspen sprouts. The combination of shading and herbivory has suppressed them. Chemult Ranger District. (Photo: Trent Seager)

Figure 6.6 Aspen Stringer

This aspen stand is a stringer along a low-lying wet area in the dry pine forest. The pre-commercial thin helps to show the stand boundary and shows that 80% of conifer removal has already occurred. Removing conifers further out allows the aspen to expand in total area and no repeat treatment would be needed for decades. Note: the lodgepole pine trees left near the aspen would make ideal jackstraw trees, and could be dropped by sawyers in a criss-cross pattern to deter deer, elk, and livestock. Chemult Ranger District. (Photo: Trent Seager)

Figure 6.7 Jackstraw

The pre-commercial thin revealed natural tree-fall that created jackstraw (downed logs). The logs protected aspen sprouts which grew into the only saplings in the stand. This is a good indication that small amounts of jackstraw are enough to deter herbivory. Treatment should include leaving some conifer trees and purposely falling them post-harvest to create jackstraw and protect the new and existing sprouts. Chemult Ranger District. (Photo: Trent Seager)

Series #4: Grazing and Fencing

Figure 6.8 Over-grazing

Cattle have been allowed to overgraze this stand for decades. The overstory is nearly gone with no aspen trees recruiting in the last 80-100 years. This stand is facing collapse. Treatment would need to include fencing and encouraging high density of sprouting (fire, root-ripping, disturbance). Private land near Klamath Ranger District. (Photo: Trent Seager)

Figure 6.9 Buck and Pole Fence

This fence shows heavy recruitment on the inside and no sprouts on the outside. Deer are the dominant herbivore, with no livestock grazing for over 25 years. This fence will decay across time from snowpack and ungulate pressure. No sprouts on the outside of the fence show high herbivory pressure from deer. Deschutes National Forest, Crescent Ranger District. (Photo: Trent Seager)

Figure 7.0 Heavy Browse

This aspen sprout has been browsed back for 15-20 years. Repeated browsing increases chance of disease. The bushy appearance and thick base of the stem shows clear signs of continued browsing. Note the new sprouts coming up from the base and nearby are also browsed. Chemult Ranger District. (Photo: Trent Seager)

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Appendix A.

TRACS Watersheds on the Fremont-Winema National Forest

The Terrestrial Restoration and Conservation Strategy (TRACS) identified species, habitats, and watersheds that are Regional priorities for restoration, conservation, and habitat enhancement on National Forest System lands in the Pacific Northwest (USDA, 2011). Aspen habitat is identified as a priority habitat. Through an intensive modeling process, a total of 35 watersheds were selected as high priority watersheds in the Pacific Northwest. Of these 35 high priority watersheds in the PNW, nearly one-third (29%) were on the Fremont-Winema National Forest (see Figure A below). The high priority watersheds (partly due to the presence and abundance of aspen) are:

1. Crooked Creek (Southwest Zone)
2. Deep Creek
3. Hog Creek-Williamson River
4. Honey Creek
5. Jack Creek-Williamson River (Northwest RD)
6. Middle Chewaucan River
7. Sycan River at Sycan Marsh (Northeast Zone)
8. Twentymile Creek
9. Upper Sycan River (Northeast Zone)
10. Willow Creek-Frontal Goose Lake (Southwest Zone)

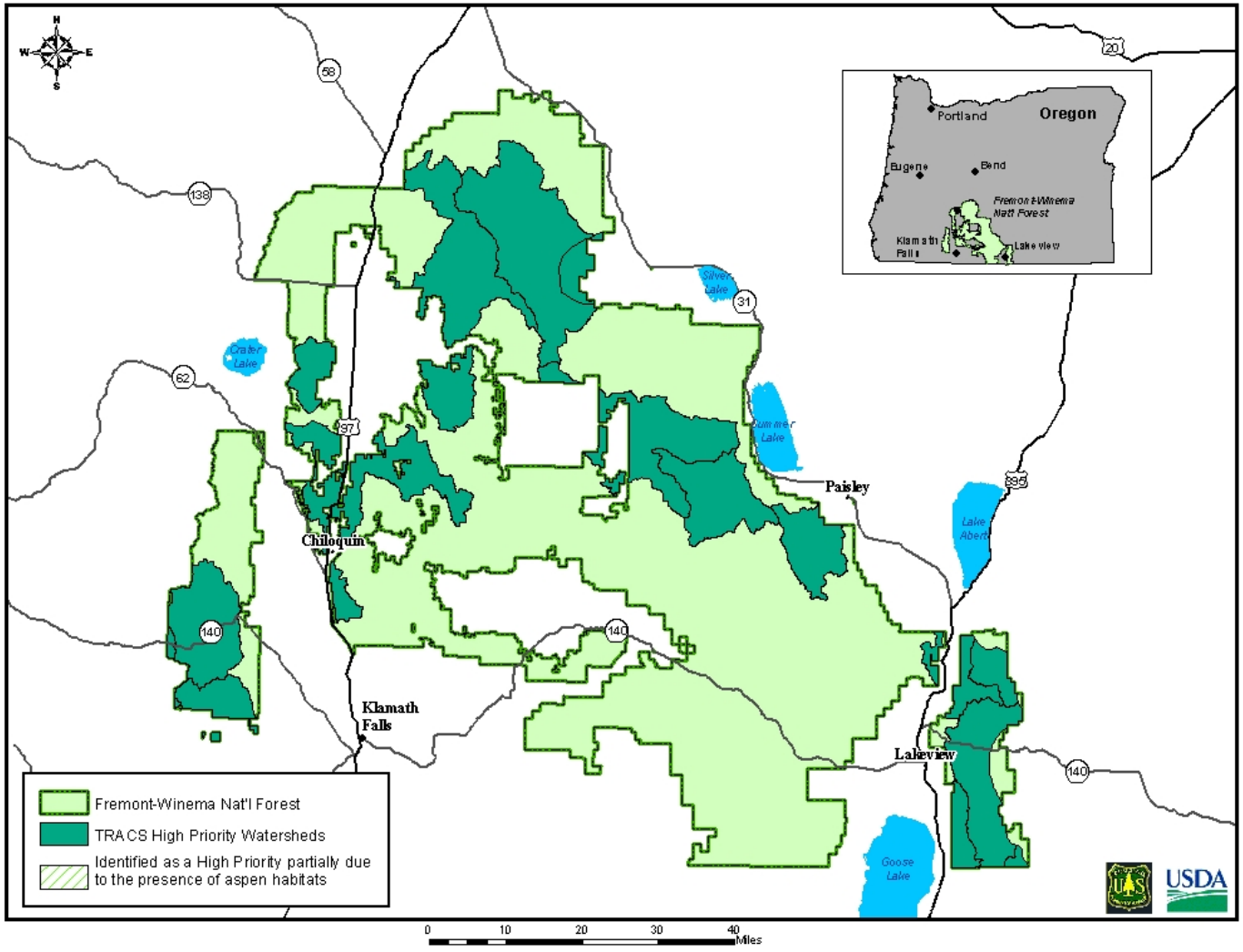

Figure A. Watersheds Identified as High Priority in the Terrestrial Restoration and Conservation Strategy (TRACS) on the Fremont-Winema National Forest.

Appendix B.

Rapid Visual Assessment Tool: Overstory, Understory, Stand Trajectory

Rapid Visual Assessment

This is done at the aspen stand level (or polygon), and unless the stand is large, can be done from a single point. The idea is to look around and assess the condition or the story of the aspen stand. When doing a rapid assessment, it is important to include understory assessment for stands missing small diameter (age class) aspen trees:

1. **Assess the OVERSTORY**:

e) How many live overstory Aspen Trees are there?

Roughly: 25, 50, 100, 150+ trees (> 8ft or 2.5m in height)

SCORE (1-10):

1	**(Low Risk)**	~ 125-150+ trees
5	**(Medium Risk)**	~ 50-100 trees
10	**(High Risk)**	~ ≤ 25 trees

f) What size classes are the overstory Aspen Trees?

Roughly how many trees are: 1-2", 2-4", or 6-9"+ at DBH?

- 1-2" DBH represent *new recruitment* (10-20 years)
- 2-4" DBH represents *recent recruitment* (25-35 years)
- 6-9"+ DBH represents *historical recruitment* (35-120 years)

These classes allow you to ID cohorts and assess wildlife habitat and resources; (see Table 1.1for details)

SCORE (1-10):

1 (Low Risk) = All size classes or Recent & New
5 (Medium Risk) = Recent & Historical
10 (High Risk) = Only 1 size class: Recent or Historical

g) How encroached is the stand by Overstory Conifer trees?

Conifers roughly cover: ~ 10%, 25%, or 50% and greater of the aspen stand area

SCORE (1-10):

1 (Low Risk) = 10% conifer

5 (Medium Risk) = 25% conifer
10 (High Risk) = 50%+ conifer

h) Are there very many aspen snags over 9" DBH?

Note that the 9"+ DBH size class is the most important for wildlife

OVERALL OVERSTORY SCORE: (add up all points)

<10 (Low Risk) = persisting for 40-60 years
11-15 (Medium Risk) = monitor & treat within 10-20 years
16-30 (High Risk) = treat within 5 years

2. **Assess the UNDERSTORY**:

b) Sprout Density: how many sprouts do you see? [see Appendix C for pictures]

- **Abundant – Common**: (Pictures 1&2): at least every 1-2'
- **Some** (Picture 3): every 5-10'; multiple patches
- **Few – Almost none** (Pictures 4&5): hard to find them; few patches

SCORE (1-10):
1 (Low Risk) = Abundant – Common
5 (Medium Risk) = Some
10 (High Risk) = Few – Almost none

b). Sprout Height: how tall are the sprouts?

- **Ankle high**: very short (6"-10")
- **Knee to Waist high**: short (2'-3')
- **Shoulder high or Taller**: tall (5'-6'; almost trees)
  Note: heavily browsed sprouts will typically all be in the same category (short); light to moderate browsing will show multiple height classes.

SCORE (1-10):
1 (Low Risk) = Shoulder high or Taller
5 (Medium Risk) = Knee to Waist
10 (High Risk) = Ankle high

c). Shrub component: for habitat type and area, what is in the stand?

- **Low**: few to no other shrubs
- **Medium**: 25% of the stand has other shrubs
- **High**: 50-80% of the stand has shrubs

Note: shrubs and flowering plants greatly increase insect and bird diversity in aspen ecosystems.

d). Conifer Saplings: how dense and tall are they?

Density:

- **Abundant – Common**: in all parts of stand, dense
- **Some**: in parts of stand, scattered
- **Few – Almost none**: here and there

Height:

- **Ankle high**: very short (6”-10”)
- **Knee to Waist high**: short (2’-3’)
- **Shoulder high or Taller**: tall (5’-6’; almost trees)

SCORE (1-10):

1 (Low Risk) = Few – Almost none
5 (Medium Risk) = Some
10 (High Risk) = Abundant – Common

OVERALL UNDERSTORY SCORE: (add up all points)

<10 (Low Risk) = ↑ aspen sprouts with ↓ herbivory & conifers
11-15 (Medium Risk) = some aspen sprouts; some herbivory & conifers
16-30 (High Risk) = few to no sprouts; ↑ herbivory & conifers

3. **FINAL: Assess the STAND CONDITION and TRAJECTORY**:
   Use the above Rapid Assessment to place the stand into one of the following categories:

PERSISTING (no concerns)

- **Overstory**: multiple cohorts present (all size classes)
- **Conifer Encroachment**: less than 10% of stand area
- **Snags**: some present for wildlife, but no large loss
- **Sprouts**: (1) common; (2) multiple height classes; (3) some recruiting into small trees (i.e., above browse height at 8’)
- **Shrub Component**: for the habitat type and area, shrubs are as expected
- **Conifer saplings**: few coming in, and still short

[Stands should score ~ 3 POINTS in Overstory to be in this category]

STABLE (fine for now and next 20 years)

- **Overstory**: multiple cohorts present (most size classes)
- **Conifer Encroachment**: less than 25% of stand area
- **Snags**: some present for wildlife, but no large loss
- **Sprouts**: (1) some to common; (2) shorter height classes; (3) few recruiting into small trees (i.e., above browse height at 8')
- **Shrub Component**: for the habitat type and area, shrubs are as expected
- **Conifer saplings**: some coming in, waist high

[Stands should score ~ 7 POINTS in Overstory to be in this category]

DECREASING (Treatment Required: overstory present, but no recruitment in last 35 years)

- **Overstory**: some cohorts present (larger size classes only)
- **Conifer Encroachment**: 25-50% of stand area
- **Snags**: 25% or more of aspen are snags or logs (carcasses)
- **Sprouts**: (1) few to some; (2) shorter; (3) none recruiting into small trees (i.e., above browse height at 8')
- **Shrub Component**: for the habitat type and area, shrubs are browsed short and scattered
- **Conifer saplings**: common, multiple height classes

[Stands should score ~ 15 POINTS in Overstory to be in this category]

THREATENED (Treatment Required: overstory decreasing and threatened by conifers, no recruitment in last 35 years)

- **Overstory**: few trees and cohorts present (larger size classes only)
- **Conifer Encroachment**: greater than 50% of stand area
- **Snags**: 50% or more of aspen are snags or logs (carcasses)
- **Sprouts**: (1) few to some; (2) shorter; (3) none recruiting into small trees (i.e., above browse height at 8')
- **Shrub Component**: for the habitat type and area, shrubs are heavily browsed or missing
- **Conifer saplings**: common to abundant, multiple height classes

[Stands should score ~ 30 POINTS in Overstory to be in this category]

Appendix C. Sprout Density Pictures for Understory assessment (by Trent Seager):

Picture 1. **ABUNDANT SPROUTS** (full release) on the Chemult Ranger District.

Picture 2. **COMMON SPROUTS** (every 1-2') on Chemult Ranger District.

Picture 3. **SOME SPROUTS** (every 5'-10' or multiple patches) on Chemult Ranger District.

Picture 4. **FEW SPROUTS** (have to walk around to find them; few patches) on the Chemult Ranger District.

Picture 5. **ALMOST NO SPROUTS** in stand on the Chemult Ranger District.

Appendix D.

Soil Resources and Information for Aspen on the Fremont-Winema National Forest

Citation: Dorr, J., C. Gebauer, K. Greulich, J. Skalka. **Interim Data for the Ecological Unit Inventory of the Winema Portion, Fremont-Winema National Forests**, Oregon & Soil Survey of Klamath County, Northern Part, Oregon.

The Ecological Unit Inventory (EUI) of the Winema portion of the Fremont-Winema National Forests is an on-going project, together with the Soil Survey of Klamath County, Northern Part. The mapping work is complete on the national forest land, and is still on-going elsewhere in the project area, on private lands, USFWS lands, etc.

Plant Associations and Aspen. The EUI correlates soils with Ecological Sites and with Plant Associations. There are a number of plant associations recognized in the EUI that are associated with aspen:

Short Name	Class Code	Source
PICO/ARUV p.a.	CLM211	R6 – R6 E 104-85
PICO/SPDO/forb p.a.	CLM313	R6 – R6 E 255-86
PICO/SPDO/CAAN15 p.a.	CLM314	R6 – R6 E 255-86
PIPO-POTR p.a.	CPH312	R6 – NR – ECOL-TP-03-2007
ABCO/CLUN2 p.a.	CWF431	R6 – R6 E 255-86
ABCO/ALIN2 p.a.	CWM111	R6 – R6 E 79-005

Soils associated with these plant associations include: Anniecreek, Aquandic Cryaquepts, Maresegg, Mesquito, Mighty, Nutmeg, Regcrust, Shortnap, Skellock, Spragueriver, Tutni, and Vitrandic Haplocryolls.

Soil map units that include these soils and plant associations as major components are: 1090, 1248, 1254, 1255, 2001, 2001, 2003, 2010, 2012, 2016, 2031, 2044, 2093 and 7802.

The smallest delineation that can be mapped at the scale of this project is 4 or 5 acres. Some existing aspen stands are smaller than that, and cannot be delineated separately. However, these smaller areas are accounted for in the EUI by describing soils of minor extent in each soil map unit. These minor extent soils are not listed in the map unit name, but are included in the data for each map unit. In assessing site potential for aspen, it is important to take into consideration both the major components named in a soil map unit as well as the minor components included in that map unit's composition.

OR683 -- Winema N.F. TEUI & N. Klamath Co. Soil Survey

Soils Associated with Aspen

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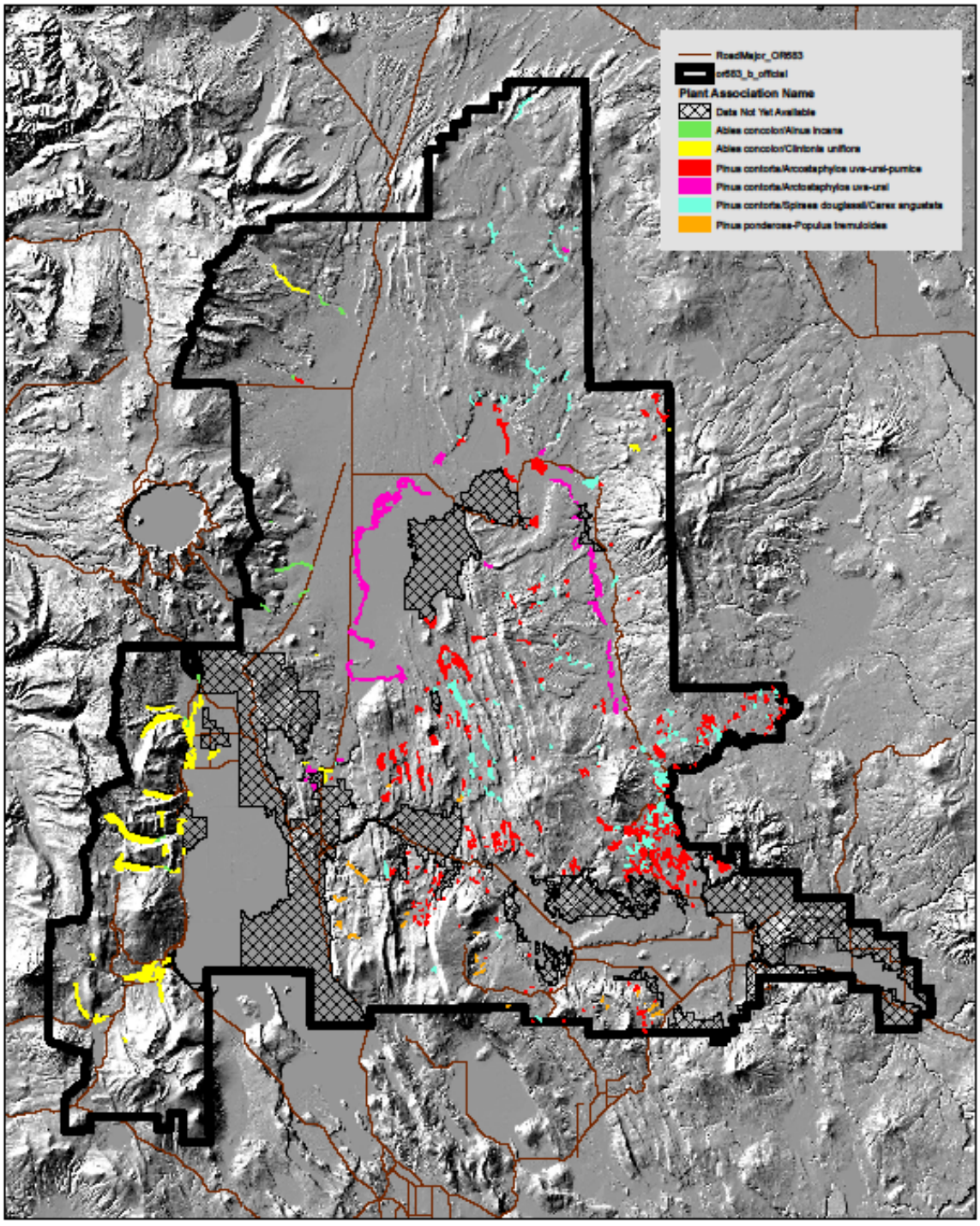
SUBJECT TO CHANGE

August, 2013



USDA-NRCS
Soil Survey Office
Klamath Falls, OR

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0 5 10 20 30 40 Kilometers

1:629,804

N

Winema National Forest Terrestrial Ecology Unity Inventory and
Soil Survey of North Klamath County

Spatial Data Summary –
Soil Map Units Associated with Aspen

Note: Draft Data -- *subject to change*

MUSYM	No. of Polygons	Acres
1090	232	2,493
1248	6	619
1254	6	1,142
1255	13	3,408
2001	31	668
2002	15	113
2003	63	2,647
2010	144	5,878
2012	41	1,035
2016	20	3,386
2031	14	297
2044	11	1,227
2093	27	333
7802	2	36

This accounts for an estimated 23,000 acres of soil types associated with aspen on the west side of the Fremont-Winema.

Appendix E.

Further Resources for Aspen Management and Restoration:

Key Publications:

OREGON

- Aspen biology, community classification, and management in the Blue Mountains, Oregon (2010)
- Aspen Persistence in Three Oregon Landscapes (2010)
- Land Manager's Guide to Aspen Management in Oregon (2010)
- ODFW Strategy Habitat: Aspen Woodlands (2006)

WESTERN U.S.

- Aspen Restoration in the Western United States
- Ecology, Biodiversity, Management, and Restoration of Aspen in the Sierra Nevada (2006)
- Guidelines for aspen restoration on the National Forests in Utah (2010)

Aspen Portals for Land Managers:

- Aspen Delineation Project:
- Western Aspen Alliance